

Amendments to the Claims:

The following lists all claims and their status:

1-4499 (cancelled)

4500. (currently amended): A method for in situ production of synthesis gas from a coal formation, comprising:

heating a section of the formation to a temperature sufficient to allow synthesis gas generation, wherein a permeability of the section is substantially uniform and greater than a permeability of an unheated section of the formation when the temperature sufficient to allow synthesis gas generation ~~within~~in the formation is achieved;

providing a synthesis gas generating fluid to the section to generate synthesis gas;

and

removing synthesis gas from the formation.

4501. (currently amended): The method of claim 4500, wherein the permeability of the section is greater than about 100 millidarcy when the temperature sufficient to allow synthesis gas generation ~~within~~in the formation is achieved.

4502. (original): The method of claim 4500, wherein the temperature sufficient to allow synthesis gas generation ranges from approximately 400 °C to approximately 1200 °C.

4503. (original): The method of claim 4500, further comprising heating the section when providing the synthesis gas generating fluid to inhibit temperature decrease in the section due to synthesis gas generation.

4504. (currently amended): The method of claim 4500, wherein heating the section comprises convecting an oxidizing fluid into a portion of the section, wherein the temperature ~~within~~in the section is above a temperature sufficient to support oxidation of

carbon ~~within~~in the section with the oxidizing fluid, and reacting the oxidizing fluid with carbon in the section to generate heat ~~within~~in the section.

4505. (original): The method of claim 4504, wherein the oxidizing fluid comprises air.

4506. (original): The method of claim 4505, wherein an amount of the oxidizing fluid convected into the section is configured to inhibit formation of oxides of nitrogen by maintaining a reaction temperature below a temperature sufficient to produce oxides of nitrogen compounds.

4507. (currently amended): The method of claim 4500, wherein heating the section comprises diffusing an oxidizing fluid to reaction zones adjacent to wellbores ~~within~~in the formation, oxidizing carbon ~~within~~in the reaction zone to generate heat, and transferring the heat to the section.

4508. (currently amended): The method of claim 4500, wherein heating the section comprises heating the section by transfer of heat from one or more ~~of~~ electrical heaters.

4509. (currently amended): The method of claim 4500, wherein heating the section to a temperature sufficient to allow synthesis gas generation and providing a synthesis gas generating fluid to the section comprises introducing steam ~~into~~to the section to heat the formation and to generate synthesis gas.

4510. (currently amended): The method of claim 4500, further comprising controlling the heating of the section and provision of the synthesis gas generating fluid to maintain a temperature ~~within~~in the section above the temperature sufficient to generate synthesis gas.

4511. (currently amended): The method of claim 4500, further comprising:
monitoring a composition of the produced synthesis gas; and

controlling heating of the section and provision of the synthesis gas generating fluid to maintain the composition of the produced synthesis gas ~~within~~in a selected range.

4512. (original): The method of claim 4511, wherein the selected range comprises a ratio of H₂ to CO of about 2:1.

4513. (original): The method of claim 4500, wherein the synthesis gas generating fluid comprises liquid water.

4514. (original): The method of claim 4500, wherein the synthesis gas generating fluid comprises steam.

4515. (currently amended): The method of claim 4500, wherein the synthesis gas generating fluid comprises water and carbon dioxide, and wherein the carbon dioxide inhibits production of carbon dioxide from carbon containing material ~~within~~in the section.

4516. (currently amended): The method of claim 4515, wherein a portion of the carbon dioxide ~~within~~in the synthesis gas generating fluid comprises carbon dioxide removed from the formation.

4517. (original): The method of claim 4500, wherein the synthesis gas generating fluid comprises carbon dioxide, and wherein a portion of the carbon dioxide reacts with carbon in the formation to generate carbon monoxide.

4518. (currently amended): The method of claim 4517, wherein a portion of the carbon dioxide ~~within~~in the synthesis gas generating fluid comprises carbon dioxide removed from the formation.

4519. (original): The method of claim 4500, wherein providing the synthesis gas generating fluid to the section comprises raising a water table of the formation to allow water to flow into the section.

4520. (original): The method of claim 4500, wherein the synthesis gas is removed from a producer well equipped with a heating source, and wherein a portion of the heating source adjacent to a synthesis gas producing zone operates at a substantially constant temperature to promote production of the synthesis gas wherein the synthesis gas has a selected composition.

4521. (original): The method of claim 4520, wherein the substantially constant temperature is about 700 °C, and wherein the selected composition has a H₂ to CO ratio of about 2:1.

β³ 4522. (currently amended): The method of claim 4500, wherein the synthesis gas generating fluid comprises water and hydrocarbons having carbon numbers less than 5, and wherein at least a portion of the hydrocarbons are subjected to a reaction ~~within~~in the section to increase a H₂ concentration of the generated synthesis gas.

4523. (currently amended): The method of claim 4500, wherein the synthesis gas generating fluid comprises water and hydrocarbons having carbon numbers greater than 4, and wherein at least a portion of the hydrocarbons react ~~within~~in the section to increase an energy content of the synthesis gas removed from the formation.

4524. (currently amended): The method of claim 4500, further comprising maintaining a pressure ~~within~~in the formation during synthesis gas generation, and passing produced synthesis gas through a turbine to generate electricity.


4525. (original): The method of claim 4500, further comprising generating electricity from the synthesis gas using a fuel cell.

4526. (currently amended): The method of claim 4500, further comprising generating electricity from the synthesis gas using a fuel cell, separating carbon dioxide from a fluid exiting the fuel cell, and storing a portion of the separated carbon dioxide ~~within~~in a spent section of the formation.

4527. (original): The method of claim 4500, further comprising using a portion of the synthesis gas as a combustion fuel to heat the formation.

4528. (original): The method of claim 4500, further comprising converting at least a portion of the produced synthesis gas to condensable hydrocarbons using a Fischer-Tropsch synthesis process.

4529. (original): The method of claim 4500, further comprising converting at least a portion of the produced synthesis gas to methanol.

 4530. (original): The method of claim 4500, further comprising converting at least a portion of the produced synthesis gas to gasoline.

4531. (original): The method of claim 4500, further comprising converting at least a portion of the synthesis gas to methane using a catalytic methanation process.

4532. (currently amended): The method of claim 4500, further comprising providing heat from three or more heat sources to at least a ~~portion~~part of the formation, wherein three or more of the heat sources are located in the formation in a unit of heat sources, and wherein the unit of heat sources comprises a triangular pattern.

4533. (currently amended): The method of claim 4500, further comprising providing heat from three or more heat sources to at least a ~~portion~~part of the formation, wherein three or more of the heat sources are located in the formation in a unit of heat sources,

wherein the unit of heat sources comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

4534. (currently amended): A method of treating a coal formation in situ, comprising:
providing heat from one or more heat sources to at least a ~~portion~~section of the formation;

allowing the heat to transfer from the one or more heat sources to ~~substantially uniformly~~ increase a permeability of the ~~portion~~section such that the permeability of the section is substantially uniform, and to increase a temperature of the ~~portion~~section to a temperature sufficient to allow synthesis gas generation;

providing a synthesis gas generating fluid to at least the ~~section~~portion of the ~~selected section~~formation, wherein the synthesis gas generating fluid comprises carbon dioxide;

obtaining a portion of the carbon dioxide of the synthesis gas generating fluid from the formation; and

producing synthesis gas from the formation.

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4535. (currently amended): The method of claim 4534, wherein the temperature sufficient to allow synthesis gas generation is ~~within~~in a range from about 400 °C to about 1200 °C.

4536. (original): The method of claim 4534, further comprising using a second portion of the separated carbon dioxide as a flooding agent to produce hydrocarbon bed methane from a coal formation.

4537. (original): The method of claim 4536, wherein the coal formation is a deep coal formation over 760 m below ground surface.

4538. (original): The method of claim 4536, wherein the coal formation adsorbs some of the carbon dioxide to sequester the carbon dioxide.

4539. (original): The method of claim 4534, further comprising using a second portion of the separated carbon dioxide as a flooding agent for enhanced oil recovery.

4540. (currently amended): The method of claim 4534, wherein the synthesis gas generating fluid comprises water and hydrocarbons having carbon numbers less than 5, and wherein at least a portion of the hydrocarbons undergo a reaction ~~within~~in the ~~selected~~ section to increase a H₂ concentration ~~within~~in the produced synthesis gas.

4541. (currently amended): The method of claim 4534, wherein the synthesis gas generating fluid comprises water and hydrocarbons having carbon numbers greater than 4, and wherein at least a portion of the hydrocarbons react ~~within~~in the ~~selected~~ section to increase an energy content of the produced synthesis gas.

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4542. (currently amended): The method of claim 4534, further comprising maintaining a pressure ~~within~~in the formation during synthesis gas generation, and passing produced synthesis gas through a turbine to generate electricity.

4543. (original): The method of claim 4534, further comprising generating electricity from the synthesis gas using a fuel cell.

4544. (currently amended): The method of claim 4534, further comprising generating electricity from the synthesis gas using a fuel cell, separating carbon dioxide from a fluid exiting the fuel cell, and storing a portion of the separated carbon dioxide ~~within~~in a spent ~~portion~~section of the formation.

4545. (original): The method of claim 4534, further comprising using a portion of the synthesis gas as a combustion fuel for heating the formation.

4546. (original): The method of claim 4534, further comprising converting at least a portion of the produced synthesis gas to condensable hydrocarbons using a Fischer-Tropsch synthesis process.

4547. (original): The method of claim 4534, further comprising converting at least a portion of the produced synthesis gas to methanol.

4548. (original): The method of claim 4534, further comprising converting at least a portion of the produced synthesis gas to gasoline.

4549. (original): The method of claim 4534, further comprising converting at least a portion of the synthesis gas to methane using a catalytic methanation process.

4550. (previously presented): The method of claim 4534, wherein a temperature of the one or more heat sources is maintained at a temperature of less than approximately 700 °C to produce a synthesis gas having a ratio of H₂ to carbon monoxide of greater than about 2.

4551. (previously presented): The method of claim 4534, wherein a temperature of the one or more heat sources is maintained at a temperature of greater than approximately 700 °C to produce a synthesis gas having a ratio of H₂ to carbon monoxide of less than about 2.

4552. (previously presented): The method of claim 4534, wherein a temperature of the one or more heat sources is maintained at a temperature of approximately 700 °C to produce a synthesis gas having a ratio of H₂ to carbon monoxide of approximately 2.

4553. (currently amended): The method of claim 4534, wherein ~~a heat source of the at least one or more of the~~ at least one heat sources comprises an electrical heater.

4554. (currently amended): The method of claim 4534, wherein ~~a heat source~~ at least one of the ~~one or more~~ heat sources comprises a natural distributed heater.

4555. (currently amended): The method of claim 4534, wherein ~~a heat source~~ at least one of the ~~one or more~~ heat sources comprises a flameless distributed combustor (FDC) heater, and wherein fluids are produced from a wellbore of the FDC heater through a conduit positioned ~~within~~ in the wellbore.

4556. (currently amended): The method of claim 4534, further comprising providing heat from three or more heat sources to at least a ~~portion~~ part of the formation, wherein three or more of the heat sources are located in the formation in a unit of heat sources, and wherein the unit of heat sources comprises a triangular pattern.

63 4557. (currently amended): The method of claim 4534, further comprising providing heat from three or more heat sources to at least a ~~portion~~ part of the formation, wherein three or more of the heat sources are located in the formation in a unit of heat sources, wherein the unit of heat sources comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

4558. (currently amended): A method of in situ synthesis gas production, comprising:
providing heat from one or more flameless distributed combustor heaters to at least a first ~~portion~~ part of a coal formation;

allowing the heat to transfer from the one or more heaters to a ~~selected~~ section of the formation ~~such that the heat from the one or more heaters substantially uniformly increases~~ to increase a permeability of the selected section such that the permeability of the section is substantially uniform, and to raise a temperature of the ~~selected~~ section to a temperature sufficient to generate synthesis gas;

introducing a synthesis gas producing fluid ~~into~~ to the ~~selected~~ section to generate synthesis gas; and

removing synthesis gas from the formation.

4559. (currently amended): The method of claim 4558, wherein the one or more heaters comprise at least two heaters, and wherein superposition of heat from at least the two heaters ~~substantially uniformly increases a~~the permeability of the selected section such that the permeability of the section is substantially uniform, and raises ~~a~~the temperature of the ~~selected~~ section to a temperature sufficient to generate synthesis gas.

4560. (original): The method of claim 4558, further comprising producing the synthesis gas from the formation under pressure, and generating electricity from the produced synthesis gas by passing the produced synthesis gas through a turbine.

4561. (currently amended): The method of claim 4558, further comprising producing pyrolyzation products from the formation when raising the temperature of the ~~selected~~ section to the temperature sufficient to generate synthesis gas.

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4562. (currently amended): The method of claim 4558, further comprising separating a portion of carbon dioxide from the removed synthesis gas, and storing the carbon dioxide ~~within in~~ a spent portion-section of the formation.

4563. (currently amended): The method of claim 4558, further comprising storing carbon dioxide ~~within in~~ a spent portion-section of the formation, wherein an amount of carbon dioxide stored ~~within in~~ the spent portion-section of the formation is equal to or greater than an amount of carbon dioxide ~~within in~~ the removed synthesis gas.

4564. (currently amended): The method of claim 4558, further comprising separating a portion of H₂ from the removed synthesis gas; and using a portion of the separated H₂ as fuel for ~~the one or more~~ of the heaters.

4565. (currently amended): The method of claim 4558, further comprising using a portion of exhaust products from one or more of the heaters as a portion of the synthesis gas producing fluid.

4566. (original): The method of claim 4558, further comprising using a portion of the removed synthesis gas with a fuel cell to generate electricity.

4567. (original): The method of claim 4566, wherein the fuel cell produces steam, and wherein a portion of the steam is used as a portion of the synthesis gas producing fluid.

4568. (currently amended): The method of claim 4566, wherein the fuel cell produces carbon dioxide, and wherein a portion of the carbon dioxide is introduced into the formation to react with carbon ~~within-in~~ in the formation to produce carbon monoxide.

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4569. (currently amended): The method of claim 4566, wherein the fuel cell produces carbon dioxide, and storing an amount of carbon dioxide ~~within-in~~ in a spent ~~portion-section~~ of the formation equal or greater to an amount of the carbon dioxide produced by the fuel cell.

4570. (original): The method of claim 4558, further comprising using a portion of the removed synthesis gas as a feed product for formation of hydrocarbons.

4571. (currently amended): The method of claim 4558, wherein the synthesis gas producing fluid comprises hydrocarbons having carbon numbers less than 5, and wherein the hydrocarbons crack ~~within-in~~ in the formation to increase an amount of H₂ ~~within-in~~ in the generated synthesis gas.

4572. (currently amended): The method of claim 4558, further comprising providing heat from three or more heat sources to at least a ~~portion-part~~ part of the formation, wherein

three or more of the heat sources are located in the formation in a unit of heat sources, and wherein the unit of heat sources comprises a triangular pattern.

4573. (currently amended): The method of claim 4558, further comprising providing heat from three or more heat sources to at least a ~~portion-part~~ of the formation, wherein three or more of the heat sources are located in the formation in a unit of heat sources, wherein the unit of heat sources comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

4574. (currently amended): A method of treating a ~~hydrocarbon-containing~~ coal formation, comprising:

heating a ~~portion-section~~ of the formation with one or more electrical heaters to a temperature sufficient to pyrolyze hydrocarbons ~~within-in~~ the ~~portion~~section;

producing pyrolyzation fluid from the formation;

separating a fuel cell feed stream from the pyrolyzation fluid; and

directing the fuel cell feed stream to a fuel cell to produce electricity.

4575. (original): The method of claim 4574, wherein the fuel cell is a molten carbonate fuel cell.

4576. (original): The method of claim 4574, wherein the fuel cell is a solid oxide fuel cell.

4577. (currently amended): The method of claim 4574, further comprising using a ~~portion~~some of the produced electricity to power at least one of the electrical heaters.

4578. (currently amended): The method of claim 4574, wherein heating the ~~portion~~section of the formation is performed at a rate sufficient to increase a permeability of the ~~portion-section~~ and to produce a substantially uniform permeability ~~within-in~~ the ~~portion~~section.

4579. (original): The method of claim 4574, wherein the fuel cell feed stream comprises H₂ and hydrocarbons having a carbon number of less than 5.

4580. (original): The method of claim 4574, wherein the fuel cell feed stream comprises H₂ and hydrocarbons having a carbon number of less than 3.

4581. (original): The method of claim 4574, further comprising hydrogenating the pyrolyzation fluid with a portion of H₂ from the pyrolyzation fluid.

4582. (original): The method of claim 4574, wherein the hydrogenation is done in situ by directing the H₂ into the formation.

4583. (original): The method of claim 4574, wherein the hydrogenation is done in a surface unit.

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4584. (original): The method of claim 4574, further comprising directing hydrocarbon fluid having carbon numbers less than 5 adjacent to at least one of the electrical heaters, cracking a portion of the hydrocarbons to produce H₂, and producing a portion of the hydrogen from the formation.

4585. (currently amended): The method of claim 4584, further comprising directing an oxidizing fluid adjacent to at least ~~the~~ one of the electrical heaters, and oxidizing coke deposited on or near ~~the~~ at least one of the electrical heaters with the oxidizing fluid.

4586. (currently amended): The method of claim 4574, further comprising storing CO₂ from the fuel cell ~~within~~ in the formation.

4587. (currently amended): The method of claim 4586, wherein the CO₂ is adsorbed to carbon material ~~within~~ in a spent ~~portion~~ section of the formation.

4588. (currently amended): The method of claim 4574, further comprising cooling the ~~portion~~section to form a spent ~~portion~~section of formation.

4589. (currently amended): The method of claim 4588, wherein cooling the ~~portion~~section comprises introducing water into the ~~portion~~section to produce steam, and removing steam from the formation.

4590. (currently amended): The method of claim 4589, further comprising using a portion of the removed steam to heat a second ~~portion~~section of the formation.

4591. (currently amended): The method of claim 4589, further comprising using a portion of the removed steam as a synthesis gas producing fluid in a second ~~portion~~section of the formation.

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4592. (currently amended): The method of claim 4574, further comprising:
heating the ~~portion~~section to a temperature sufficient to support generation of synthesis gas after production of the pyrolyzation fluids;
introducing a synthesis gas producing fluid into the ~~portion~~section to generate synthesis gas; and
removing a portion of the synthesis gas from the formation.

4593. (original): The method of claim 4592, further comprising producing the synthesis gas from the formation under pressure, and generating electricity from the produced synthesis gas by passing the produced synthesis gas through a turbine.

4594. (original): The method of claim 4592, further comprising using a first portion of the removed synthesis gas as fuel cell feed.

4595. (original): The method of claim 4592, further comprising producing steam from operation of the fuel cell, and using the steam as part of the synthesis gas producing fluid.

4596. (original): The method of claim 4592, further comprising using carbon dioxide from the fuel cell as a part of the synthesis gas producing fluid.

4597. (original): The method of claim 4592, further comprising using a portion of the synthesis gas to produce hydrocarbon product.

4598. (currently amended): The method of claim 4592, further comprising cooling the ~~portion~~section to form a spent ~~portion~~section of formation.

4599. (currently amended): The method of claim 4598, wherein cooling the ~~portion~~section comprises introducing water into the ~~portion~~section to produce steam, and removing steam from the formation.

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4600. (currently amended): The method of claim 4599, further comprising using a portion of the removed steam to heat a second ~~portion~~section of the formation.

4601. (currently amended): The method of claim 4599, further comprising using a portion of the removed steam as a synthesis gas producing fluid in a second ~~portion~~section of the formation.

4602. (currently amended): The method of claim 4574, further comprising providing heat from three or more heat sources to at least a ~~portion~~part of the formation, wherein three or more of the heat sources are located in the formation in a unit of heat sources, and wherein the unit of heat sources comprises a triangular pattern.

4603. (currently amended): The method of claim 4574, further comprising providing heat from three or more heat sources to at least a ~~portion~~part of the formation, wherein

three or more of the heat sources are located in the formation in a unit of heat sources,
wherein the unit of heat sources comprises a triangular pattern, and wherein a plurality of
the units are repeated over an area of the formation to form a repetitive pattern of units.

4604-5149 (cancelled)